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FINAL REPORT

CONTRACT Nonr-496(01)

with

THE INSTITUTE FOR ASSOCIATED RESEARCH

HANOVER, N.H.

Submitted July 2, 1954

by

Hadley Cantril  
Project Director, Nonr-496(01)  
President, The Institute for Associated Research

List of books, articles and reports prepared in connection with Contract Nonr-496(01) with the Institute for Associated Research, Hanover, N.H.

#### Books

Ittelson, William H. The Ames demonstrations in perception. Princeton University Press, Princeton, N.J., 1952.

Kilpatrick, F. P. Human behavior from the transactional point of view. Institute for Associated Research, Hanover, N.H., 1952.

#### Articles

\*Slack, Charles W. Learning in simple one dimensional tracking. Amer. J. Psych., 1953, 66, 33-44.

Slack, Charles W. Some characteristics of the "range effect." J. Exp. Psychol., 1953, 46, 76-80.

#### Minographed reports

Ames, Adelbert, Jr. and Cantrell, Hadley. Further notes toward an understanding of human behavior: values, choice, and action. Oct. 1951.

Hildum, Donald C. Thoughts on transactional psychology and its relation to language. Sept. 1952.

Kilpatrick, F. P. Demonstrations in perception: a guide to their interpretation and significance. Jan. 1952.

Kilpatrick, F. P. Motivation, perception and action. Mar. 1953.

Kilpatrick, F. P. Some suggestions for experimentation stemming from a transactional point of view. Jan. 1953.

\*Wittreich, Warren J. An investigation into the nature of aniseikonic distortion. Mar. 1954.

#### Motion Picture (Photo Report)

Demonstrations in perception. Produced by U.S. Naval Photographic Center, Department of the Navy. (25 min., 16 mm., black and white, sound)

\* Study initiated under Institute for Associated Research contract, but completed under Princeton University contract.

## INTRODUCTION

Certain things should be kept in mind in connection with this final report on Contract Nonr-496(01) with the Institute for Associated Research, Hanover, N. H. During 1952 and 1953, this contract ran concurrently with N6onr-27014 with Princeton University, Princeton, N.J. Professor Cantril acted as Research Director for both projects. The research problems being worked on under the two contracts stemmed from the same theoretical considerations and, in many instances, the same research assistants and research associates would at one time be employed under the Princeton contract and at another time under the Institute contract. This highly flexible arrangement proved to be very beneficial for the conduct of research and for the employment of research personnel. However, it did create a problem of dual administration and makes extremely difficult the task of separating out those aspects of research which should be credited to 496(01) from those which should be credited to 27014.

The above should make it easy to understand another major consideration which should be kept in mind—that is, that the termination of the contract with the Institute for Associated Research was primarily an administrative termination, and did not mean the termination of research for the Navy on

the problems being studied as of September 15, 1953, the termination date. All significant research still under way was taken over by the personnel employed under the Princeton University Navy contract. Since a great deal of research has been conducted at Princeton during the past year and a great deal learned about some of the problems which were still in the formative stage in September of 1953, some of what is included in the following report is stated in the light of findings which have appeared subsequent to the termination of the Institute contract. Perhaps it would be possible to prepare a report which would leave out of account all the research since September of 1953, but it would appear both unnecessary and unwise to do so.

In summary, the following pages report those aspects of our total research program which should be credited to the Institute for Associated Research Contract; some of it, however, evaluated in the light of work done subsequently under the Princeton Navy contract.

#### DISSEMINATION OF BASIC THEORY AND APPARATUS

At the time the contract with the Institute was originated, there was agreement between the members of the Neuropsychiatric Branch of the Bureau of Medicine and Surgery and the personnel

of the Institute for Associated Research that a major share of our early effort should be directed toward making available to psychiatrists and psychologists, particularly those in the Navy, the basic aspects of the perceptual theory which had been worked out and the items of demonstrational and experimental apparatus which had been devised. It was felt that considerable progress with respect to theory and experimental apparatus had already been made by Institute research personnel and that the Navy would benefit directly from making this knowledge available for integration into the theoretical and experimental program of the Navy. In addition, it was felt that the Navy would benefit from having this material communicated to interested research workers, including those in other branches of the service and in universities and research institutions working on problems of perception. To this end three major projects were undertaken.

The first of these was the publication of the handbook, HUMAN BEHAVIOR FROM THE TRANSACTIONAL POINT OF VIEW, edited by F. P. Kilpatrick. This is a 259-page manual divided into three parts. The first part, "Demonstrations and Theory," contains seven chapters. The second part, entitled "Some Representative Research Papers," consists of an additional seven chapters. Part three, entitled "Some Implications of the Demonstrations and Theory," contains four chapters plus an addendum and an annotated bibliography. It was printed

in 1952 and distributed to a list of 250 individuals supplied by the Navy. An additional 250 copies was purchased by the Institute and distributed at cost to those who requested it. Interest in the handbook was extremely high and very soon the entire supply was exhausted so that it was found necessary to prepare a second printing. This second printing of 300 copies was done without cost to the Navy and has been distributed at cost during the past year. The supply now is virtually exhausted.

The second major project under this heading was to make available the experimental apparatus which had been devised over the years by personnel of the Institute for Associated Research, especially Adelbert Ames, Jr. It was felt that the best way to do this was to prepare detailed construction drawings so that interested parties could reproduce the apparatus in their own shops. Also photographs of the finished apparatus, detailed operating instructions, and descriptions of typical phenomena to be observed were prepared by W. H. Ittelson. This work culminated in 1952 in the publication by the Princeton University Press of the book, THE AMES DEMONSTRATIONS IN PERCEPTION by W. H. Ittelson.

A third project, which was also undertaken early in the history of the contract, was the preparation of a photo report involving six of the Ames demonstrations. We had found in the past that it was very difficult for people to understand either



the theory of perception or the experimental findings unless they had at least to some degree experienced the visual phenomena associated with the demonstrations. In order to make it possible for a large number of people to experience some of the phenomena, a 16-millimeter black and white sound movie of six of the demonstrations was prepared by the United States Naval Photographic Center with the collaboration of W. H. Ittelson and F. P. Kilpatrick. Numerous copies of this movie were made. Free loan distribution through the Audio-Visual Training Section, Bureau of Medicine and Surgery, the Institute for Associated Research, and the Psychology Department at Princeton University was arranged. In addition, F. P. Kilpatrick prepared a supplement entitled, "Demonstrations in Perception: a Guide to their Interpretation and Significance." Whenever the film was loaned by either the Institute or Princeton University, this supplement accompanied the film.

After termination of the Institute contract, all copies of the film held by the Institute were forwarded to the Audio-Visual Training Section, Bureau of Medicine and Surgery. One copy has been retained at Princeton University. Requests continue to come in to the Institute and to Princeton University and in almost all cases they are referred to the Audio-Visual Training Section. The wide-spread demand for the film, which was indicated in our special report of June 26, 1952, has

continued. It is being used by psychologists, optometrists, psychiatrists, educators and others.

It is our feeling that these three projects undertaken to make the Institute experimental findings and demonstrations widely available has met with considerable success. When the Institute contract was begun, only a very few laboratories were using any of the Institute apparatus; at the present time one or more of the Institute demonstrations are being employed in more than 125 research or educational centers both here and abroad. It seems likely that Navy psychiatry, along with other psychiatry, will benefit from the research thus stimulated.

#### PERCEPTION AND LANGUAGE

The task of relating transactional perceptual theory and experimental work to problems of language was begun by Donald Hildum working under the direction of F. P. Kilpatrick, and the first study was summarized in a progress memorandum entitled, "Thoughts on Transactional Psychology and Its Relation to Language." It included a general theoretical analysis of the language problem from the transactional point of view and concluded with a pilot study of the differential language patterns of children, seniles, schizophrenics and normal adults, employing data previously reported by Cameron. The work thus begun was taken over under

the Princeton Navy research contract and a number of further studies were done, including a factor analysis of written and spoken language as it relates to various personality syndromes. Analysis in this study shows that there is a greater than chance correspondence between some language features and some personality features. As yet, this correspondence is not at all usable as a diagnostic tool. A great deal more refinement of the measures is necessary, and our research suggests that the direction of refinement should not be toward a simple frequency count. It appears that in language we are dealing with a series of choices, none of which are entirely free. If some sort of estimate can be made of the transitional probabilities and the flow of speech, then each choice perhaps can be weighted according to the degree of freedom with which it was made. Second order transitions are not too difficult to check. Third orders are tedious but possible, and fourth orders can be practically checked only by machine. In view of this rapid increase in complexity, it is obvious that much more information is present in any sample of speech than can be practically used. However, it is hoped that even second order transitions may provide a valuable refinement of the dimensions of speech and personality. The probability of this being true can be increased by obtaining language samples under some standard verbal situations.

Another finding with respect to language which had its

beginning in the studies originated under the Institute contract relates to the problem of rigidity in language behavior. Whenever tension or stress is aroused, the individual tends in his perceptual organization to resist the change called for by new impingements from the environment and to hold on to a stable perceptual absolute or constancy. This appears to apply as well to language behavior, with the result that whenever a person is under tension or stress his symbolic processes tend to become more rigid and inflexible and he leans more heavily on well-established categorizations, stereotypes, etc. One implication for therapy, of course, is that the person can be helped to escape the traps of semantic and perceptual inflexibility through techniques which will encourage relaxation and the reduction of tension and stress.

Another follow-up finding, which will be mentioned here only in passing because it will soon be published as a report under the Princeton University Navy contract, concerns the relationship between verbal categorization and perceptual learning. It appears that verbal categorization and cognitive organization tend to have an inhibiting effect on perceptual learning, at least in its early stages. This would appear to be an excellent problem for further experimental work as the implications for therapy are considerable. If it holds true in the therapeutic situation, then means of escaping the inhibiting

effect of verbalization and verbal categorization early in the psycho-therapeutic process become matters of central interest.

#### RESEARCH AT NMRI

During the last year of the Institute contract, Charles Slack, one of our most able research associates, was assigned as a guest scientist to the Naval Medical Research Institute at Bethesda under a cooperative arrangement. While there he worked with Thompson, Gilder, and Calloway.

In his work he emphasized the study of the dependencies which exist between one act and another, especially in the experimental task of tracking. He concerned himself with problems of the sequential effects in tracking of steps (that is, sudden displacements of the target) and of judgments of the size of a visually perceived object. He first turned his attention to the abstraction of the kinds of dependencies (learning) which can be observed in the tracking situation. He summarized his work in the article, "Learning in Simple One-Dimensional Tracking," published in the American Journal of Psychology. In this article he pointed out how certain types of learning are sources of non-linearity. He also discovered one kind of learning not previously reported—that is, learning without change in performance.

Later he undertook further study of one of these types

of learning and published his results as "Some Characteristics of the Range Effect" in the Journal of Experimental Psychology. He showed that the range effect was a clear-cut function of speed stress--that is, the greater the speed stress in any situation the more dependent the individual becomes upon past experience with the result that his performance becomes less related to immediate input. These results suggest that contrary to previous theory, the range effect is not a range effect at all but is a dependency based upon a very few immediately preceding responses.

This research immediately gave rise to the question as to whether or not the effects of stress upon sequential performance would hold true generally for different stresses and different sorts of tasks. Subsequently, experiments were undertaken in which stress-like physiological reactions were produced by the use of amyl-nitrite, and cold pressor to the foot. In the case of amyl-nitrite, benzedrine and placebos were used as controls. The tasks used for checking the effects of these conditions were simple one-dimensional step-function-input tracking, size distance judgments both in the laboratory and outside in the normal environment, and the speed and amount of perceptual alteration under conditions of induced aniseikonic distortion. The data were consistent throughout and showed that stress produces

an increased tendency to rely upon previous experience, with correspondingly less dependence upon present information, independent of the particular type of stress-inducing conditions employed. Later results with alcohol, which is a kind of stress-producing drug for some people, also are in line with the other research. Another follow-up study in this line was recently conducted under the Princeton contract, and consisted of a study of anticipation of human movements under conditions of speed stress using a different type of eye-hand task than tracking. Results are consistent with the previous findings.

The final stage of Slack's work at NMRI consisted of some further studies on the range effect. This work contains two parts. The first is a theoretical argument from tracking data which proposes a transactional view of stimulus, rejecting a naive stimulus-response point of view, and insisting that at a minimum the stimulus must at least be the error signal. It appears from this work that the stimulus is that abstraction which must be discovered or created by the subject in order that his action may be functional to the task at hand.

The second part of this work consists of an empirical test of a mathematical statement of some dependency functions in tracking. One of the primary hypotheses of transactional psychology is that all our perceptions, including the perception of movement, are in large part functions of a weighted average

of previous experience. Any test of this hypothesis in a concrete situation must begin by adequately defining the meaning of past experience. In simple one-dimensional tracking it is possible to define operationally the experience of the subject. It was Slack's hypothesis that, on the average, the error before correction in response to any particular step function input could be predicted by a short-term, weighted-average hypothesis as well as or better than it could be predicted by the long-term range hypothesis or level of adaptation notion which seems to underlie much of current thinking on the subject. The specific hypothesis which was stated in mathematical form was that the error in initial response to any step would be equal to a weighted sum of the presented step and steps previous, plus a constant and variable error. The weights in this case were expected to drop off quite rapidly (four steps back would be weighted zero) as contrasted with the range notion which perhaps implied that all the weights would be equal. In order to test the validity of the model it was applied to the observed data from several different experiments using different sequences of steps. All of these experiments were of essentially the same design. After instructions and a warm-up period, subjects were presented with a sequence of step displacements at least six steps long. A sequence was repeated over and over enough times to establish an average response error to each displacement in the series. The position on the field and the direction



right or left of the steps were varied from repetition to repetition, but each time the subject approached a particular step, his past experience with previous amplitudes was a constant. Eight experiments of the above design were done.

If the phenomenon observed is a function of the range, or of the mean, or of any stationary characteristics of the distribution of inputs, then the observed data should be fit best by a straight line. However, if the phenomenon is a sequential one, depending upon a weighted average of a small number of previous experiences, then the model proposed above should fit the observed data better than a straight line. Two tests of the significance of the difference in goodness of fit were done. The results support the general hypothesis that perceptions are in large part functions of a weighted average of previous experience.

Another bit of research by Slack departs from the general line of that already discussed. He made a study of induced emotional depression brought on by upsetting the form world stability through prolonged wearing of aniseikonic glasses. Slack used himself as a subject, wearing aniseikonic glasses for one week. He concurrently underwent very complete diagnostic testing and daily psychiatric interviews. Results of wearing the glasses were marked emotional depression followed by some degree of adaptation. Removal of the glasses resulted in feelings of elation so great that Dr. Slack felt that he

had to put the glasses back on and gradually adapt himself to not wearing them. The clinical leads in this study are numerous. Of particular interest is the relationship between mood and the degree of prognostic reliability of perceiving. The experimental results are consistent with those of workers who have induced neurotic behavior in animals. Follow-up studies are planned.

#### DEVELOPMENTAL STUDIES OF PERCEPTION

Under the Institute contract there was begun a series of studies directed primarily toward some aspects of the genesis of perception, using school children in the age range four to fourteen as subjects. One of the studies was concerned with the self-image concept as revealed through analysis of the results of selective perceptual distortion of mirror images of the self and of others by subjects wearing aniseikonic glasses and viewing their own images and the images of others in a full length mirror. Numerous experimental difficulties peculiar to dealing with children had to be met and overcome, but at last a satisfactory procedure was developed for studying the relationship between the perception of the mirror image of the self and of an age mate.

Another part of this same genetic study with the school children employed a newly designed thereness-thatness table

which is extremely simple in both construction and use. It is not a projector model, but requires that actual objects be placed on a moving track. Distance settings of objects of varying degrees of familiarity to children of different age levels were obtained.

Collateral information obtained from the children consisted of draw-a-person tests scored by a newly-devised objective scoring system, school records, scores on psychological tests administered by the school, and teachers' ratings of the children on various personality variables.

At the termination of the Institute contract, this entire genetic study was in the data stage. Dr. Wittreich, working under the Princeton University contract, has taken over this work and has made himself responsible for the analysis of the data and the writing of a report. At the present time the data analysis is virtually complete and it is anticipated that a rough draft report will be ready sometime in August. It is too early to anticipate very much of the contents of that report, except to say that very clear-cut differences in the self-image as studied by this technique show up for the different age levels and for the two sexes. In general these differences would seem to follow what might be called a "physical-functional" pattern rather than the traditional psychoanalytic self-image pattern.

#### APPARATUS DEVELOPMENTS

The major apparatus developments have been measuring devices adapted to the demonstrational equipment. At the time the Institute contract was initiated, a number of our potentially most useful demonstrations were severely limited from an experimental point of view because of the lack of techniques for precise measurement of the perceptual phenomena involved. Numerous difficulties had to be overcome in creating the necessary supplementary apparatus, and these difficulties were overcome only through a great deal of experimentation. Our aim in each case was to secure a measure which was not only reliable, but provided the best single index to the total perceptual change occurring in the situation.

One extremely useful development is the measuring instrument created for use with aniseikonic glasses in the leaf room. These glasses have lenses which alter the relative sizes of the retinal images in the two eyes, usually resulting in marked distortion in the perception of whatever is being viewed. For almost every observer there is an appreciable time lag between putting on these distortion-producing glasses and the appearance of any distortion of the object at which he looks, and even more time elapses while the apparent shape of the object gradually alters until it finally reaches a fairly stable maximum.

Ittelson designed an apparatus which permits the continuous recording of both the speed and amount of perceptual alteration. At eye level along the back wall of the leaf room is placed a rod whose tilt can be controlled by the observer, and is automatically recorded. The observer is seated looking into the room, either wearing no glasses or his normal corrective lenses. He is told to set the rod so that it appears parallel, for example, to the ceiling of the room and to maintain the rod apparently parallel to the ceiling at all times. He is then given some practice in adjusting the rod from various pre-set tilts. As soon as he is familiar with the apparatus, he again sets the rod apparently parallel to the ceiling and the aniseikonic glasses are suddenly placed over his eyes. As the room changes in appearance for him, he alters the rod setting. The apparent distortion of the room, both as to speed and amount, then can be read directly from the continuous record of the position of the rod. Ordinarily continuous recording on a kymograph is employed.

This device was used in some of the stress studies previously referred to, and since that time, under the Princeton contract, has been used in a number of pilot studies with patients at the Naval Medical Center.

Another significant advance has been in the measurement of perceptual change in the monocular distorted room. Early in the history of the Institute contract, we turned our attention

to developing means of measuring the rate and amount of perceptual learning in the distorted rooms. When the interior of a properly constructed distorted room is viewed with one eye from the proper position, it is seen as being perfectly normal in shape. No amount of advance knowledge concerning the actual shape of the room and no amount of time spent in just looking at the static configuration is effective in altering the way in which it is seen. However, the observer can, through such means as tossing balls in the room or feeling around in it with a stick, learn to see more and more of the "true" shape of the room. Here we have a device admirable for studying the process of perceptual learning, especially if the rate and amount of perceptual learning can be accurately measured. This learned alteration is gradual and progressive, making it possible to analyze the effects of systematically altering such variables as amount of practice, kind of practice, motivation, amount and kind of conflicting cues, etc.

By September of 1953, two devices had been created for measurement in the distorted room situation. One of them was a leveling rod thrust in through the left side of the room. It was manipulated by the experimenter in accordance with instructions given by the subject. The subject's task in all cases was to have the rod adjusted so that it looked parallel to how he saw the floor, or to how he saw the ceiling. The tilt of the rod could then be read off in degrees. It was

found that this device gave measures which roughly approximated what the subject was perceiving, but that it was insensitive, particularly in the cases where a large amount of distortion was being perceived.

The second instrument, which was somewhat more satisfactory in that it provided more precise measurement throughout the whole range of distortion to be measured, consisted of a small bar set parallel to the back wall of the room and centered opposite the observer's eye. It was geared to a selsyn which in turn was connected to another selsyn which the observer himself could manipulate. As in the previous case, the observer's task was to set the leveling bar so that it appeared parallel to how the floor looked, or to how the ceiling looked.

It was at this stage of development of the distorted room measuring devices that the Institute work was transferred to the Princeton contract. Subsequent use of these instruments has resulted in the isolation of at least three distinct processes in perceptual learning, and in a study which indicates that advance knowledge concerning the actual shape of the room has an initial inhibiting effect on perceptual learning. Also, they made possible a study testing out our early formulations concerning the role of action in perceptual learning and a major modification of this aspect of the theory in line with experimental results.

Improvement of distorted room perceptual learning measuring devices has continued under the Princeton contract. A new instrument has recently been built but not yet tried out. It seems likely that these measuring instruments, used in conjunction with the distorted room, have a bright future in the area of perceptual learning. They have already made it possible to add a great deal to our knowledge, and we have only begun to tap the possibilities.

Another development which should be reported here because a major share of the work on it was done under the Institute contract, is Wittreich's scale measurement of aniseikonic distortion. Both congenital and artificially induced aniseikonia produce a visual experience of distortion of sizes, shapes, and distances of objects. However, the same degree of aniseikonia will not necessarily produce the same amount of perceived distortion for different subjects, nor will the same subject necessarily perceive equal amounts of distortion in different environments.

Wittreich used a graded series of aniseikonic lenses running from very low power to quite high power, employing the psycho-physical methods of limits and reproduction. His object was to establish a measuring scale for distortion of objects--that is, the amount of optical change required to bring about a perceived change. The experiment was successful in that it showed that a lens power scale can be used in



quantifying variations in distortions observed under conditions of artificial aniseikonia. With certain qualifications, this method provides a reliable measure of differences between people in their perceived distortion of the same object, or of differences between perceived distortions of different objects by the same person.

This method of scale-measuring perceived aniseikonic distortion of whatever is being viewed when aniseikonic glasses are being worn proved extremely valuable for later experimentation. For example, one very recent study done at the Naval Medical Research Institute showed that subjects perceive significantly less distortion of the figures of amputees and simulated amputees than they do of normal figures. Another recent example is a study in which Naval trainees were asked to view an officer and an enlisted man while wearing aniseikonic lenses. The scale measurement of the aniseikonic distortion showed that the perceived distortion of the enlisted man was considerably more than that of the officer figure, and that this difference was due to the factor of rank as it affected the psychological organization of the trainee.

A point of possible interest to Navy medicine is the fact that these improvements in the methods for measuring perceptual change, coupled with our gradually increasing understanding of the relationship of type and amount of perceptual change to

various personality, learning, and motivational factors, makes it likely that the day is not far off when a number of the demonstrational devices will be amenable to use as diagnostic and testing instruments.

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